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Experimentally induced states of mind determine abstinent smokers' level of craving in reaction to smoking-cues



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ABSTRACT

Introduction: The present study aims to contribute to our knowledge on the causes of variations in experienced craving of (ex)smokers. The general idea is tested that when (ex)smokers are exposed to a smoking-cue, their level of craving is determined by the momentary *state of mind* through which the smoking-cue is interpreted.

Methods: A cue-reactivity paradigm in temporary abstinent smokers is applied to trigger craving responses under different experimentally induced states of mind. Craving is assessed with a three-item self-report measure. In study 1 (N = 120) a self-affirmation procedure is applied right before abstinent smokers were exposed to their own smoking paraphernalia. In study 2 (N = 140) abstinent smokers received bogus feedback inducing a high or low self-efficacy and strong or weak positive outcome expectations.

Results: Study 1 showed a significant interaction: When involvement was high, self-affirmation increased the level of craving but when involvement was low self-affirmation lowered craving. Study 2 also showed a significant interaction: Only when the positive outcome expectation of smoking were high, self-efficacy lowered the level of craving. All analyses were controlled for the number of cigarettes smoked a day and number of past quit attempts.

Conclusions: The present studies provide experimental evidence that levels of craving can be determined by momentary *states of mind*. This theoretical perspective can be integrated in existing conditioning and social cognitive learning perspectives on craving and substance use.

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1. Introduction

Craving for the substance plays an important role in the maintenance of drug use, such as cigarette smoking. Several studies show that craving levels during the early phases of quitting are predictive of later relapse (Baer & Lichtenstein, 1988; Brandon, Tiffany, & Baker, 1987; Dijkstra & Borland, 2003; Killen & Fortmann, 1997; Shiffman et al., 1997). In addition, cue-induced craving has been shown to be related to smoking and relapse (Carpenter et al., 2009; Ferguson & Shiffman, 2009; Waters et al., 2004). Because craving is defined as a motivational state (Marlatt & Gordon, 1985; Baker, Morse, & Sherman, 1986) that can be a cause of relapse, understanding the determinants of craving is an important step in controlling relapse in smoking cessation. Especially the observation of the moment to moment variance in craving of smokers and ex-smokers (Shiffman, 2009) is puzzling and needs further explanation.

1.1. Cue-reactivity

An important research paradigm for studying craving is that of cue-reactivity. In this paradigm, smokers or ex-smokers are exposed to smoking-cues to assess their reactions (Balter, Good, & Barrett, 2015; Carter & Tiffany, 1999; Ferguson & Shiffman, 2009), and several sources of (variance in) craving have been identified: To start with, levels of craving are related to different (presentations of) smoking-cues, for example, one's own cigarettes, a confrontation with another person smoking one's favorite brand, or reading a script about being upset and wanting to smoke badly (Carter & Tiffany, 1999; Niaura et al., 1998). In addition, physiological factors influence the level of craving, for example, individuals' heaviness of smoking (Carpenter et al., 2009; Sayette, Martin, Wertz, Shiffman, & Perrott, 2001), and nicotine replacement therapy (Waters et al., 2004). Furthermore, affect has been shown to be related to craving (for a review Heckman et al., 2013). In more recent years, cognitive factors have been shown to influence levels of craving. For example, several studies show that *expectations* of different kinds influence craving: Expectations about receiving actual nicotine replacement or not (Schlagintweit, Good, & Barrett, 2014), about whether a nicotine patch will be effective (Fucito & Juliano,

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2007), expectations about the effects of nicotine (Harrell & Juliano, 2012), and expectations about being allowed to smoke or not during cue-exposure (Dols, Willems, van den Hout, & Bittoun, 2000; Dols, van den Hout, Kindt, & Willems, 2002; Field & Duka, 2001). Also, cognitively primed self-schemas (Shadel & Cervone, 2006), and antismoking advertisements (Kang, Cappella, Strasser, & Lerman, 2009; Lee, Cappella, Lerman, & Strasser, 2013) have been shown to determine levels of craving. Overall, several sources of the variance in craving have been mapped.

The main theoretical framework to understand the variance in craving has been the classical conditioning (or learned association) paradigm: Situational cues that have been repeatedly paired with smoking in the past elicit craving (Ferguson & Shiffman, 2009). In addition, social cognitive theories have been applied to understand the occurrence and variance of craving (Brandon, Herzog, Irvin, & Gwaltney, 2004; Marlatt & Gordon, 1985; Niaura, 2000). These models define a sequence of psychological and physiological events after exposure to the cue, including the activation of positive outcome expectations of smoking. In essence, the social cognitive theories follow the conditioning paradigm but provide the “black box” with more “content”, instead of only describing it in terms of automated, unconscious or associated relations. In these models the strength – and thus the variance – of the craving primarily depends on: 1) the strength of the conditioned link between the specific cue and past smoking; 2) the strength of the positive outcome expectations that are activated. In the present study we try to understand the variance in craving through another psychological model that is less focused on conditioning but more on the psychological meaning given to the smoking-cue, in the concept of the *state of mind*. This theoretical perspective can be integrated with the above perspectives, further shifting the focus from the stimuli to the psychological processes that interpret the stimuli.

1.2. States of mind

We introduce a general higher level psychological framework of understanding the effects of smoking-cues on craving: The level of craving depends on the activated *state of mind* through which smoking-cues are perceived (not necessarily an affective state). The state of mind may be caused by the smoking-cue itself, or by other stimuli, independent of the smoking-cue. The state of mind may be related to smoking (feeling confident to be able to abstain) or general (feeling good about oneself). States of mind are conceptualized as interpretative frameworks: The activated state of mind directs attention and guides the interpretation of incoming information (Erdley & D'Agostino, 1988; Kunda, 1999; Markus, 1977). According to Sedikides and Skowronski (1991), stimuli – i.e., the smoking-cue – can be encoded as instances of the cognitive structure that is the most highly active in memory. In mindset priming this is demonstrated in a “carry-over” effect in which an experimentally activated state of mind determines the processing of subsequently presented stimuli or tasks (Bargh & Chartrand, 2000).

Thus, when trying to explain the effects of smoking-cues on craving, we must take into account how the smoking-cues are perceived: different states of mind may give different meanings to the smoking-cues. Within this framework we conducted two studies. The first study tried to demonstrate that the smoking-cue itself brings about a self-regulatory cognitive reaction that determines the level of craving that can be changed by inducing a state of mind that is unrelated to smoking. The second study tested whether states of mind can interact, in predicted ways.

The first study is conducted on the basis of the premise that the smoking-cue itself induces a state of mind. When studying states of mind it is essential to know what the starting point or the baseline is; how do abstinent smokers perceive a smoking-cue when we do not induce a specific state of mind? When an ex-smoker is exposed to a

smoking-cue, contrasting thoughts, feelings, and goals may be activated. This state can be conceptualized as a motivational conflict (Baumeister & Vohs, 2007) or a self-control conflict (Myrseth & Fishbach, 2009), and it needs resolution. This state not only concerns one's smoking behavior, but also the person's self-image; it can be regarded as a self-threat (Steele, 1988; Steele & Liu, 1983). According to the self-affirmation theory, from an evolutionary point of view it is inadequate and non-adaptive to have contradicting psychological states. When the conflict state concerns the violation (i.e., smoking or wanting to smoke) of an important value (i.e., health), the awareness of this contradiction is conceptualized as a self-threat that is experienced as feeling ashamed, dissatisfied and angry with oneself (Dijkstra & Buunk, 2008). The core of the self-affirmation theory is that people try to get rid of the self-threat: By defensively lowering the craving or its psychological causes, in reaction to a smoking cue, the self-threat may be averted. From the perspective of the self-control conflict (Myrseth & Fishbach, 2009), this defensive action can be seen as a conflict resolution that leads to lower temptations (Myrseth, Fishbach, & Trope, 2009) or as self-regulation in function of sticking to a goal (Baumeister & Vohs, 2007). This reasoning is also consistent with Niaura's (2000) Dynamic Regulatory Model of Drug Relapse, in which initial responses to a smoking-cue may activate cognitive coping reactions that feed back. The present study might reveal that people's spontaneous levels of craving may already result from self-regulative actions, mobilized by a conflict or self-threat. In addition, this study will try to demonstrate this defensive self-regulation by inducing a general state of mind (i.e., unrelated to smoking) that can prevent defensive self-regulation.

The second study is designed to test the notion that states of mind interact with each other. To make a next step in understanding the effects of states of mind, and further approach the complex and seemingly fuzzy reality, two states of mind will be induced to see whether they show synergistic effects. The social cognitive perspective of smoking and relapse may help define relevant states of mind that might determine how smoking-cues are perceived. In this perspective, two constructs are relevant: Positive outcome expectations of smoking and self-efficacy expectations to be able to refrain from smoking (Marlatt & Gordon, 1985; Niaura, 2000). Positive outcome expectations of smoking refer to smokers' anticipated positive effects of smoking (Doran, Schweizer, & Meyers, 2011; Ikard, Green, & Horn, 1969; Niaura, Goldstein, Ward, & Abrams, 1989; Tate & Stanton, 1990; Urban & Demetovics, 2010; Wetter et al., 1994). According to Marlatt and Gordon (1985), positive outcome expectations are at the basis of craving: “...craving is a motivational state associated with a strong desire for an expected positive outcome” (pp. 138). Therefore, it is safe to predict that when smokers anticipate strong positive outcomes of smoking at the moment that they are exposed to smoking-cues, they will experience stronger craving.

Besides positive outcome expectations, self-efficacy expectations play a role in smoking and relapse. In the framework of craving to smoke, self-efficacy expectations concern the perceived personal ability to be able to not give in to the craving. Self-efficacy has been shown to be related to relapse in many studies (Gwaltney, Metrik, Shiffman, & Kahler, 2009). In addition, self-efficacy can be expected to lower craving when it strengthens the individual's expectation to refrain from smoking in a specific situation (Dols et al., 2000, 2002). In further support of this notion, empirical studies show a negative relation between self-efficacy and craving (Dijkstra & Borland, 2003; Shadel & Cervone, 2006). It is expected that when smokers have a high self-efficacy at the moment that they are exposed to smoking-cues, they will experience less craving.

Thus, positive outcome expectations and self-efficacy expectations both provide different but related interpretative frameworks. They refer to appraisals of different aspects of the smoking-cue. It is tested here whether these appraisals get mixed, to form a new synergistic appraisal of the smoking-cue that influences craving.

1.3. The present studies

In two laboratory experiments, the general idea is tested that when smokers are exposed to a smoking-cue, the smokers' state of mind at that moment influences the level of craving. In study 1, we assume that the mere exposure to the smoking-cue (while not being allowed to smoke yet) will induce a psychological conflict that leads to a self-control response that influences the level of craving. A self-affirmation procedure is applied in half of the participants to prevent the need to self-regulate. In study 2, two smoking-specific states of mind based on the social cognitive theory (Bandura, 1986) are induced: Before smokers are exposed to the smoking-cue (while not being allowed to smoke yet), they are led to belief that smoking has few versus many positive outcome expectations or that they have a high versus a low self-efficacy to refrain from smoking. In both studies, abstinent smokers are confronted with their own cigarettes to trigger craving right after they have been exposed to the respective experimental manipulations. The self-reported craving during the exposure to the smoking-cue is the dependent measure.

2. Study 1

In this study, we argue that the mere exposure to the smoking-cue will lead to a defensive state of mind that lowers craving, at least when the (ex)smoker's goal to refrain from smoking is activated (Stroebe, Koningsbruggen, Papies, & Aarts, 2013). To test whether this is true, we can apply a procedure of which we know that it takes away such a defensive reaction in function of lowering a self-threat: A self-affirmation procedure. A self-affirmation procedure is applied before people are confronted with stimuli (Critcher, Dunning, & Armor, 2010), in the present case, with their own smoking paraphernalia. In a self-affirmation procedure, important individual characteristics of participants are affirmed (McQueen & Klein, 2006). The effect is that participants feel good about themselves; the procedure makes participants realize that their self-worth does not hinge on temporary or situational evaluations of their self-image. Therefore, a self-affirmation procedure induces a psychological state of "open-mindedness". The effect is that people dare to face the potential threat and they accept the threat without denial (Harris & Napper, 2005; Sherman & Cohen, 2002). Thus, when abstinent smokers are affirmed before they are exposed to smoking paraphernalia, they will no longer have the inclination to reduce the self-threat using a defensive reaction: They accept the aversive feelings caused by the confrontation and they have no longer the need to lower the craving or its psychological causes to protect their self. As a result, the self-affirmation procedure will lead to an increase in craving.

However, not all smokers will show a defensive reaction to lower the craving when they are exposed to smoking-cues, so, the self-affirmation procedure will only increase craving in some people. Especially people who are highly involved will display a defensive reaction that can be prevented by a self-affirmation procedure (Eagly, 2007; Liberman & Chaiken, 1992). In the present context involvement concerns the involvement in the issue of quitting smoking; especially these smokers may experience the conflict that they will try to resolve. Therefore, especially in highly involved ex-smokers a self-affirmation can be expected to prevent this defensive reaction (Harris & Napper, 2005; Reed & Aspinwall, 1998; Sherman, Nelson, & Steele, 2000) and lead to increased (acceptance of) craving.

2.1. Participants

120 smoking students participated in this study for a payment of 15 euros each. All participants were temporary abstinent smokers, because ex-smokers could not be included: We think that it is unethical to seduce ex-smokers to smoke in an experimental procedure. Participants

were instructed to stay abstinent for at least 4 h before the start of the experiment.

2.2. Procedure

Participants were invited to take part in a study about smoking and smoking behavior. When participants entered the lab-room, they were asked to hand in their cigarettes. Participants were told that this was done because they "needed" the cigarettes later in the experiment. After this, participants were seated behind a computer (separate cabins). Before the participants were exposed to any manipulation, pretest measurements were conducted. After finishing the pretest, they were randomly assigned to a self-affirmation or a no-self-affirmation condition.¹ After the manipulation, participants were exposed to the smoking-cue, during which they answered the posttest questions that comprised the dependent measures.

2.3. Materials and measures

2.3.1. Pretest measures

Participants started with questions about gender, age, education level and smoking status and history.

Involvement was measured with a scale comprised of two questions ($r(120) = .33, p < .001$): 'How important is quitting smoking to you?' and 'How important is your health to you?' (endpoints 'not at all important' (1) and 'very important' (7)). The higher the score, the higher the involvement in the topic of smoking and smoking cessation is thought to be.

2.3.2. Self-affirmation manipulation

The self-affirmation procedure was offered before participants were exposed to the smoking-cue and it was based on Allport, Vernon and Lindzey's (1960) *study of values* (Kooze, Smeets, Van Knippenberg, & Dijksterhuis, 1999). Participants were asked to indicate on a list of six domains, the domain they value the most and the domain they value the least. The domains were religion, politics, social aspects of life, economy, esthetics, and theory. Next, in the self-affirmation condition participants were offered ten questions with one of two answering options always referring to the domain they had indicated to be the most important for them. For example, when the participant had indicated that he or she most valued the social aspects of life, a question could be: "Who contributed the strongest to mankind progress? 1) Newton, because of his theoretical mechanics or; 2) Martin Luther King, human rights fighter". In the non-self-affirmation condition, participants were offered ten questions about their least important value. This self-affirmation procedure has been shown to significantly lower defensive reactions towards a health persuasive message (Dijkstra & Van Asten, 2013).

2.3.3. Smoking-cue exposure

After the manipulation, participants were instructed to ask the experimenter for their cigarettes. Participants who didn't bring their cigarettes (26 participants), borrowed their favorite brand (or a brand that resembled their own brand) from the instructor. They were asked to rate the flavor of the cigarettes. The exposure to smoking paraphernalia has been shown to be a robust procedure for inducing drug related reactivity (Carter & Tiffany, 1999).

2.3.4. Posttest measures

After and during the smoking-cue exposure – their cigarettes lying in front of them and not being allowed to smoke – their craving was

¹ The original design also included a manipulation of self-control: Participants were asked to briefly write about a situation in which they had shown to have control over their impulses, or not. However, this manipulation seemed to have failed or to be inert as it was not significantly related to craving, not as a main effect and not in interaction with involvement or self-affirmation. Therefore, we do not present these data.

measured. The craving measure was composed of three items on 9-point scales. The items were: 'Do you feel like smoking right now?'; 'At this moment, do you look forward to lighting and smoking a cigarette?'; 'How strongly do you desire to smoke right now?' (endpoints 'not at all' (1) to 9 'very much' (9)). The three item scores were averaged to form the individual craving score (Cronbach's $\alpha = .96$).

To check the self-affirmation manipulation, participants were asked how many positive thoughts they had during the experiment. Positive thoughts are considered to reflect acceptance of the incoming information (Petty, Wells, & Brock, 1976): 'How many positive thoughts did you have during this experiment?' (endpoints 'very few positive thoughts' (1) and 'very many positive thoughts' (7)).

2.4. Results and discussion

2.4.1. Participant characteristics

The mean age of the 120 smokers was 21.22 years ($SD = 2.27$), with a minimum of 18 and a maximum of 28 years. 52.6% was women. Smokers smoked on average 12.0 cigarettes a day ($SD = 4.33$).

2.4.2. Manipulation check

A one-way analysis of variance (ANOVA) was conducted to test whether the self-affirmation manipulation was effective. Participants in the self-affirmation condition reported significantly more positive thoughts ($M = 4.70$, $SD = 1.27$) than participants in the no self-affirmation condition ($M = 4.08$, $SD = 1.18$), $F(1, 118) = 7.59$, $p < .01$.

2.4.3. Interaction effects on craving

The interaction between involvement and self-affirmation was tested using ANCOVA with craving as a dependent variable and the number of cigarettes smoked a day and the number of quit attempts as covariates. This two-way interaction was significant, ($F(1, 114) = 13.01$, $p < .001$, $\eta_p^2 = .102$). To investigate the meaning of this interaction, the main effect of self-affirmation was tested when involvement was low and when involvement was high. To this purpose, the complete dataset was used to model a group scoring low on involvement and a group scoring high on involvement, by adding and subtracting 1 standard deviation from the mean-centered mean, respectively (Cohen, Cohen, West, & Aiken, 2003).

As expected, among highly involved abstinent smokers self-affirmation significantly increased the reported craving ($p < .05$; Fig. 1). This suggests that when highly involved participants were affirmed, they were able to face the self-threat and the causally related craving; no self-regulatory mechanisms were needed anymore. This effect of self-affirmation implies that when participants were not affirmed, they applied self-regulatory defenses, presumably to cope with the threat induced by the smoking-cue. This notion is supported by the significant relation ($p < .01$) between involvement and craving when participants were not affirmed: Lower involvement, meaning less defensiveness, was related to higher craving. Thus, especially in the high involved the smoking-cue activated self-regulatory defenses that could be prevented by self-affirmation.

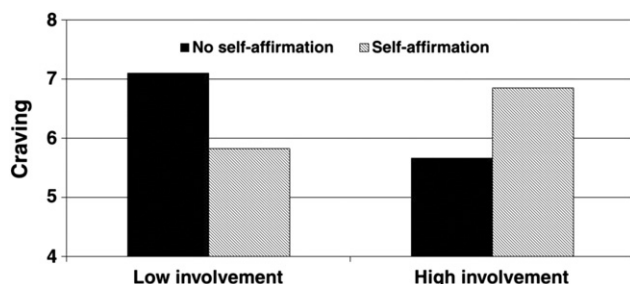


Fig. 1. The effects of involvement and self-affirmation on craving.

Among low involved participants the self-affirmation procedure led to a significant drop in craving ($p < .01$), meaning that inducing open-mindedness led participants to report lower craving. It may be that low involved participants experienced a lower self-threat because of their low involvement and, therefore, did not feel the need to get defensive. They may have used a "default" emotion regulation to face the cue. However, when these participants were enticed to process the information on the smoking-cue open-mindedly by applying the self-affirmation procedure, the threat may have become too strong to face. Such a reaction to an "overload" of threat is well documented in the field of persuasion (Block & William, 2002; Burnkrant & Unnava, 1995; Meyers-Levy & Peracchio, 1996; Na, 1999). Moreover, Reed and Aspinwall (1998) also showed that in low involved participants, the effects of self-affirmation were the opposite of the effect in highly involved participants. Although this reasoning has its basis in theories and studies on persuasion, the three core elements of our theorizing – a threat, a level of involvement, and a defensive reaction to lower a cause of the threat – also play a central role in these studies on persuasion. Lastly, when participants were affirmed, lower involvement was significantly related to lower craving ($p < .05$). Because all analyses were corrected for smoking and quitting behavior, we assume that the low craving in the low involved participants is not caused by less physical reactivity.

The finding that self-affirmation increases craving when involvement is high, is explained by self-affirmation taking away defensiveness. However, it is possible that self-affirmation also has other effects. That is, because self-affirmation should affirm and boost the self, it might take away negative emotions (Tesser, 2000). However, in that case it could be expected that self-affirmation would lower craving, not increase it. Among the low involved this interpretation would hold, and it cannot be ruled out that self-affirmation might work differently in low and high involved. Future studies can further disentangle the effects of self-affirmation.

We assume that in the no-affirmation condition smokers perceived the smoking-cue through a default or spontaneous state of mind: This specific no-self-affirmation manipulation is designed to be neutral and it can be expected to be inert. These data, therefore, suggest that there are relevant individual differences among abstinent smokers that determine craving in smoking-cue studies that are never taken into account: The present study suggests that when people are not affirmed, the extent to which they are involved in the issue determines their level of craving. Not addressing these individual differences may obscure or bias effects of smoking-cues. Therefore, smoking-cue reactivity studies might always need to include such individual difference measures.

3. Study 2

In this second study the possible interaction between two smoking specific states of mind – positive outcome expectations of smoking and self-efficacy expectations with regard to refraining from smoking – will be addressed. On the basis of the relations of positive outcome expectations of smoking and self-efficacy expectations on the one hand and craving on the other hand, as reviewed in the introduction, we might expect the following effects: When self-efficacy is low, stronger positive outcome expectations will lead to more craving. When self-efficacy is high, this will be prevented. When positive outcome expectations are weak, self-efficacy expectations will not further lower the craving, but when positive outcome expectations are strong, self-efficacy expectations will lower the craving.

3.1. Method

3.1.1. Participants and design

140 smoking students participated in this study for a payment of 15 euros each. The same procedure and inclusion criteria were used as in study 1 (e.g., they had to be abstinent for at least 4 h).

Participants were randomly assigned to one of four conditions in a 2 (weak versus strong positive outcomes) \times 2 (low versus high self-efficacy)-design. Thus, in total four different states of mind were induced. A state of mind was induced by providing the participants with bogus feedback that was said to be based on the pretest measurements.

3.2. Procedure

Participants were invited to take part in a study about smoking and smoking behavior. When participants entered the lab-room, they were asked to hand in their cigarettes. After this, participants were seated behind a computer (separate cabins). Before the participants were exposed to any manipulation, pretest measurements were conducted. After finishing the pretest, participants received condition specific bogus feedback regarding their self-efficacy (high or low) to quit smoking and regarding their positive outcome expectations (strong or weak). After the manipulation, participants were exposed to the smoking-cue, during which they answered the posttest questions that comprised the dependent measures.

3.3. Materials and measures

3.3.1. Pretest measures

Participants started with questions about gender, age, education level, smoking status, and smoking history.

Following this, participants answered twenty-eight filler questions about health and health behavior (on a 5-point “I do not agree” (1)–“I do agree”-scale) with two aims. Firstly, the items were meant to disguise the assessment of self-efficacy and positive outcome expectations; the items of these measures were mixed with the filler items. Secondly, participants were told that the feedback they received was based on the pretest scores. By designing the filler questions as ambiguous (it was not immediately clear what they assessed), it was thought to support the perceived reliability of the feedback participants would receive. Two examples of ambiguous questions are: ‘Smokers choose to smoke’ and ‘Smokers are no junks’. The actual measure of self-efficacy concerned the ability to resist the temptation to smoke in six situations, presented after the statement: ‘It is hard to refrain from smoking when...’: ‘someone offers you a cigarette’; ‘you’ve just finished your meal’; ‘you’re feeling down’; ‘you are going out or having a party’; ‘you’re taking a break’; ‘you’re feeling stressed’. The measure of positive outcome expectations concerned five possible outcomes of smoking presented after the statement: ‘Smoking helps me to...’: ‘cope with anger’; ‘cope with stress’; ‘concentrate’; ‘relax’; ‘stay alert’.

3.3.2. Manipulations

After participants filled in the pre measurement they received the condition-specific bogus feedback that comprised the main manipulation. Participants were instructed to carefully read the feedback text.

3.3.3. Self-efficacy manipulation

In the low self-efficacy condition participants were led to believe that on the basis of the pre measurement it seemed that they had a low self-efficacy to quit smoking: The chance to successfully quit smoking was said to be quite low for them, and if they would undertake a quitting attempt, they would give up easy (61 words). In the high self-efficacy condition, participants were led to believe that they had a high self-efficacy to quit smoking: Their chance to successfully quit smoking was high, and if they would undertake a quit attempt, they would not give up (60 words).

3.3.4. Positive outcome expectations manipulation

In the weak positive outcome expectations condition, participants were led to believe that that on the basis of the pre measurement it seemed that they saw few benefits of smoking, that smoking was more of a habit to them, and that it had no important function for

them. In addition, it was stressed that, indeed, smoking has no beneficial effects whatsoever (63 words). In the strong positive outcome expectations condition, participants were led to believe that they saw strong benefits of smoking and that smoking had important functions for them. In addition, it was stressed that, indeed, smoking has strong beneficial effects (60 words).

3.3.5. Smoking-cue manipulation

After reading the bogus feedback, the participants were exposed to their cigarettes, using the same procedure as in Study 1. Thirty-eight participants did not bring their own cigarettes.

3.3.6. Posttest measures

The craving measure was the same as used in Study 1 (Cronbach's $\alpha = .96$). To check the manipulations, self-efficacy and positive outcome expectations were assessed with short measures, using the following two items on a 7-point scale: ‘Are you able to quit smoking?’ (endpoints ‘not at all able to’ (1) and ‘definitely able to’ (7)) and ‘Does smoking have positive outcomes for you?’ (endpoints ‘no positive outcomes at all’ (0) and ‘many positive outcomes’ (7)).

3.4. Results and discussion

3.4.1. Participant characteristics

The mean age of the 140 smokers was 22.34 years ($SD = 2.37$), with a minimum of 18 and a maximum of 28 years. 65.7% were women. Participants smoked 14.65 cigarettes a day on average ($SD = 4.81$).

3.4.2. Manipulation check

A one-way analysis of variance (ANOVA) was conducted to test whether the manipulations of self-efficacy and the positive outcome expectations were effective. Participants in the high self-efficacy condition reported higher self-efficacy ($M = 5.29, SD = 1.27$) than participants in the low self-efficacy condition ($M = 4.91, SD = 1.31$), but the difference only approached significance, $F(1, 138) = 3.07, p = .08$. Participants in the low positive outcome expectations condition reported less positive outcomes ($M = 3.73, SD = 1.35$) than participants in the high positive outcome expectations condition ($M = 4.24, SD = 1.37$), $F(1, 138) = 4.97, p < .05$. It is concluded that the manipulations were partly successful.

3.4.3. The interaction effect on craving

A 2 (low/high self-efficacy) \times 2 (weak/strong positive outcome expectations) ANCOVA with craving as dependent measure and number of cigarettes smoking and number of quitting attempts as covariates showed no significant main effects of the self-efficacy manipulation and of the positive outcome expectations manipulation. However, the interaction between the self-efficacy and the positive outcome expectations manipulations on craving was significant, $F(1, 132) = 10.12, p < .01, \eta_p^2 = .07$. To test whether this effect existed beyond participants' level of self-efficacy and positive outcome expectation at pretest, the pretest measures of self-efficacy and positive outcome expectations were included in the model as covariates. The model parameters hardly

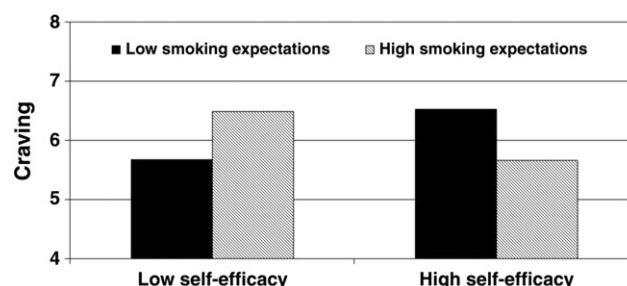


Fig. 2. The effects of self-efficacy and smoking expectations on craving.

changed, indicating that the effects of the manipulations on craving were beyond the individual difference before the manipulation. Fig. 2 shows the mean scores on craving in the four conditions.

It was expected that higher self-efficacy would be related to lower craving and stronger positive outcome expectations would be related to stronger craving. However, both effects were only present under conditions: Contrast analyses showed that only when self-efficacy was low, stronger positive outcome expectations led to significantly stronger craving ($p < .05$). In addition, only when positive expectations were strong, higher self-efficacy led to lower craving, although this effect only approached significance ($p = .076$). Unexpectedly, when smokers saw weak positive outcome expectations, higher self-efficacy was related to stronger craving, although this effect was not completely significant ($p = .055$). Thus, only in the case of strong positive outcome expectations, self-efficacy seemed to do its craving-lowering work. It looks like self-efficacy became only relevant or was only mobilized when the temptation to smoke (on the basis of strong positive outcome expectations) was “alarmingly” high; only then self-control based on the sufficient level of self-efficacy was triggered to lower the craving.

These data show that smoking-cues can be processed through a state of mind that consists of a combination of different meaning giving perceptions. Thus, explaining reactions towards smoking-cues needs a complex theoretical framework in which states of mind not necessarily work additive but also interactive. Moreover, there is no reason why even higher order interactions could not occur. Future studies should further address these interactive effects of these states of mind on craving.

The effects of the experimental manipulations existed beyond the individual differences on self-efficacy and positive outcome expectations and the number of cigarettes smoked a day and the number of past quit attempts. The manipulation checks revealed that we were able to induce lower and higher levels of self-efficacy expectations and positive outcome expectations. These data provide further evidence that self-efficacy and positive outcome expectations play an important role in craving and the relapse process, in concert (Gwaltney, Shiffman, Balabanis, & Paty, 2005; Niaura, 2000; Shadel & Cervone, 2006).

4. General discussion

Although several questions remain unanswered, we demonstrated that different states of mind elicit different levels of craving. These effects were found independent of participants' quitting and smoking behavior and holding the smoking-cues constant (one's own cigarettes). In this context a state of mind refers to all kinds of psychological states that influence how smoking-cues are perceived. For example, smoking-cues may be seen as a threat to one's health, as a threat to one's self-regard, as an obstacle to abstinence, or no longer important enough to take the risk.

In study 1 a general, well-defined not smoking-related state of mind was induced: Self-affirmation was thought to induce open-mindedness, and its effects here revealed the presence of defensive a state of mind that was evoked by confrontation with the own cigarettes in highly involved abstainers. This state may be equivalent to the demonstrated increased neural activity in the prefrontal cortical regions of ex-smokers during exposure to a smoking-cue (Nestor, McCabe, Jones, Clancy, & Garavan, 2011). The state of being self-affirmed influenced the perception of the smoking-cue, but it can be expected to also influence the perception of other stimuli (Correl, Spencer, & Zanna, 2004; Wakslak & Trope, 2009). In study 2, the states of mind were related to smoking: Expecting strong or weak positive effects of smoking or experiencing control or not over smoking. At the moment of exposure to their cigarettes, these states of mind – also in interaction with each other – determined how smokers perceived the smoking-cue. All in all, these data suggest that craving can be influenced by smoking-related as well as by general states of mind.

The states of mind influenced craving beyond the number of cigarettes smokers smoked a day: All analysis were controlled for the influence of this most important potential confounder. This strongly suggests that craving, as assessed in the present studies, is not only determined by biological factors but also has more varying or volatile psychological causes. In addition, the present states of mind framework may be positioned within the conditioning and social cognitive perspectives of craving between the stimulus and the reactions, thereby more explicitly incorporating the basic importance of psychological processes in giving meaning to all incoming information (Bandura, 1986; Beck, 1995; Frijda, 1986). In these perspectives of craving and drug use, a stimulus triggers craving but this relation (at least in social cognitive models) is mediated by physiological and psychological processes. For example, in Niaura's (2000) Dynamic Regulatory Model affect or contextual stimuli trigger a chain of subsequent reactions, possibly including the activation of outcome expectations, coping reactions and relapse. The *state of mind* perspective can be positioned in-between the stimuli and the reaction chain: States of mind determine what smokers “see” when they are exposed to a smoking cue, and they determine the subsequent reaction chain; the physiological and psychological processes that are triggered.

The present theorizing implies that when ex-smokers move through their environments encountering smoking-cues, their craving reactions towards the same stimuli may strongly differ from moment to moment: Talking to another ex-smoker may temporarily make salient one's accomplishments (e.g., “I am already refraining from smoking for ten days now”), and bring about a state of mind of high self-efficacy, while the confrontation with a tobacco advertisement may bring about a state of mind of expecting strong positive outcomes of smoking, and a subsequent self-affirming conversation may make the ex-smoker open-minded. These states of mind can be expected to lead to different levels of craving in reaction to the same smoking-cues. From a meta-cognitive point of view this may have subsequent effects on smokers' motivation to invest in their quitting attempt. That is, ex-smokers with the final goal of continuous abstinence are thought to search for feedback on whether they are on the right track; they want to know whether their efforts are paying off (Kluger & DeNisi, 1996), and whether their self-regulation is adequate (Baumeister & Vohs, 2007). Fluctuating levels of craving may lead to uncertainty on how well their quit attempt is going, thereby undermining their motivation to invest and persevere (Menninga, Dijkstra, Gebhardt, & Siero, 2011). The large variation in craving in quitters throughout the day may also explain why craving is – according to Wray, Gass, and Tiffany (2013) – not consistently related to treatment outcomes: The commonly used craving measures may not grasp all changes in craving. In addition, one reason why the level of craving can be low is that the abstainer experiences a strong conflict in reaction to a smoking-cue, and subsequently down-regulates the craving. However, the low craving may wrongly suggest that the abstainer is not moved by the cue. This might partly explain why it is hard to predict abstinence or treatment outcomes from measurements of craving. These notions might be addressed in future studies on the relation between craving and relapse.

The results of the present studies should be interpreted against the background of the methodology, of which the measure of craving is an important aspect. We assessed craving with a three-item self-report measure on the desire and inclination to smoke. This measure does not assess physiological aspects of craving, nor does it explicitly comprise the anticipation of positive outcomes of smoking. It is meant to be a parameter of the psychological experience (the desire) of being pulled towards smoking. The use of brief self-report measures of craving, even 1-item measures, is very common in cue-exposure research (Baumann & Sayette, 2006; Carpenter et al., 2009; Dols et al., 2002; Sayette et al., 2001; Waters et al., 2004). Moreover, West and Ussher (2010) showed that a brief measure of craving was evenly sensitive and reliable as a more comprehensive measure. Still, it is important to

replicate the present findings with broader measures of craving, including its physiological equivalents.

The uncertainties regarding the experimental manipulations are also worth mentioning: Besides the fact that the self-efficacy manipulation in study 2 did not reach the conventional level of significance, we cannot rule out that our manipulations had effects for other reasons than they were designed for. For example, self-efficacy manipulations may have increased self-esteem, while the self-affirmation manipulation may have induced a positive mood. Future research should further check these possibilities.

A limitation of both studies is related to the samples of participants. We were interested in craving in recently quitted ex-smokers, but because of ethical reasons we could not include this group: Seducing ex-smokers with smoking-cues may lead to relapse. Therefore, we used temporary abstinent smokers, who were instructed not to smoke at least four hours before the experiment (unfortunately, no data were available on whether they actually adhered to this request). The fact that 'real' ex-smokers couldn't be used may have biased the results at some point. Especially with regard to the expectation of our participants that they were allowed to smoke again after the experiment, they differ from "real" ex-smokers. On the other hand, our experiment was designed to show differences between manipulations on craving; it is not immediately clear how the manipulation would work qualitatively different in "real" ex-smokers.

The present studies provide experimental evidence that craving is not only determined by automated physiological reactions but also by the psychological interpretations of smoking-cues. In addition, we showed that smoking-cues themselves may induce a state of mind – probably related to coping with the confrontation – that influences the perception of the smoking stimuli, and that states of mind interact; leading to a qualitative different state of mind through which the smoking-cue is interpreted. Our findings may also be relevant for other health behaviors in which craving and self-regulation play a role, such as, alcohol consumption and dietary behaviors. When it comes to designing relapse prevention interventions, the observed phenomenon should be taken into account: Risk situations are not only defined by the confrontation with a smoking-cue, or the (smoking) history of the situation, but also by more short-lived states of mind, even those not related to smoking. Helping individuals to recognize and influence these states of mind might be important to prevent relapse.

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Contributors

Both authors contributed equally to the design of the study, the analysis of the data and the writing of the manuscript. Dr. Menninga conducted and supervised the experiments.

Conflict of interest

Both authors declare that they have no conflicts of interest.

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